Available online at www.sciencedirect.com

SciVerse ScienceDirect

Procedia - Social and Behavioral Sciences 46 (2012) 5306 – 5310

Procedia
Social and Behavioral Sciences

WCES 2012

Talking about mathematics: quadratic equations

Elcin Emre [a] *, Ziya Argun[a]

[a]*Gazi University, Ankara,Turkey*

Abstract

The aim of this study was to reveal the structure of mathematics classroom discussions about the concept of quadratic equations. The participants of this qualitative study are 10th grade students, and the data was collected through the classroom observations. Observations in a period of six courses, each of them approximately 45 minutes long, were analyzed through content analysis. In our findings, we noticed that listening to students' talks about their own mathematical experience provides a data base for investigating students' learning level on quadratic equations.

Keywords: Quadratic equations;classroom discussions; talking

1. Introduction

Teachers spend a substantial amount of time talking to students, explaining mathematical activities in classrooms. In mathematics, there is much emphasis on mathematical technical words, on the representations of symbols, and on the meaning of these words and symbols. Some mathematics educators think that *"carefully prepared lessons and explanations during the practicing do not necessarily have their desired outcomes"* (Leder, 1990). For many years researchers avoid to the study of contexts, such as classroom discussions (Shuell, 1996). However, investigations about mathematical classroom discussions may lead to methods for helping students overcome their difficulties and they will also contribute implications for teacher education (Kim et. al, 2005). One of the reasons, why the study of classroom discussion has become critical for understanding educational processes and outcomes, is considering classroom discussion as a key point in increasing our understanding of what and how students learn (Turner & Meyer, 2000).

1.1 "Talking" and "Discussion"

Throughout the literature, social aspects of the classroom studies are related to mathematics by the concept of mathematical discourse (Matson, 2010). Moschkovich (2003) defines mathematical discourse by elaborating on Gee's (1996) general definition of discourse:

> *"A Discourse is a socially accepted association among ways of using language, other symbolic expressions, and artifacts, of thinking, feeling, believing, valuing and acting*

*ElçinEmre Tel.: +0903122023660
E-mail address: elcinemre@gazi.edu.tr

1877-0428 © 2012 Published by Elsevier Ltd. Selection and/or peer review under responsibility of Prof. Dr. Hüseyin Uzunboylu
Open access under CC BY-NC-ND license. doi:10.1016/j.sbspro.2012.06.428

that can be used to identify oneself as a member of a socially meaningful group or social network, a socially meaningful role."(stated in Matson, 2010).

Therefore, participating in mathematical discourse (or being part of a discourse community) involves much more than talking about mathematics. Because, as Gee mentioned above, discourse also includes social aspects of learning. In fact, becoming competent in a particular discourse (e.g. mathematical) is as multi-faceted as involving into a new culture. However, talk, and subsequently different types of talk, such as exploratory, explanatory, reflexive, challenging etc. are specific examples of discourse practices that can be related with mathematics, and mathematics learning and teaching (Esmonde, 2009). If we define talk as verbal discourse practice (Pimm, 1987), then the term discussion refers to a specific kind of talk. Discussion should include both debating of meanings and sharing points of view with others (Pimm, 1987). Talk (a discourse practice), and subsequently discussion, become part of mathematics itself when we begin to see mathematics as a social activity (Matson, 2010).

Using mathematical objects while communicating is a fundamental issue in mathematics classroom (NCTM, 2000), and discussion is one of the forms of communication. According to Hoyles (1985) an active participation in a discussion will be either talking or listening and this 'talking' has two qualitatively different functions, first the cognitive function for the articulation of one's own thought processes, and the latter communicative function for explaining one's ideas to others. Both types of talking allow reflection and thinking on one's own ideas and help them to crystallize their ideas (Hoyles, 1985).

Using discussion in the mathematics classroom emphasizes the significance of the socio-cultural setting in the understanding of what and how students learn (Turner & Meyer, 2000). Behind this, context is critically important in any investigation of discussions. In this regard, purpose of this study was to reveal the structure of mathematics classroom discussions about the concept of quadratic equations.

2. Methodology

The study was conducted in a tenth-grade mathematics classroom in a medium-sized central city in Turkey. The teacher of the classroom in which the study was conducted, has been teaching high school level mathematics for 20 years. Before collecting the data, students and the teacher were informed about the study. After receiving permission from Ministry of Education in Turkey, the researcher explained to teacher that they will not use the real name of the school, the teacher and students in their research paper. And if required, the teacher and students can read the research paper after the study is finished. We prepared a lay summary for students to give details about the research. Before starting classroom observations, one of the researchers, who made the observations, read lay summary aloud in the classroom. This researcher introduced herself as a researcher who is interested in the ways students learn and study mathematics. During this period, the researcher positioned herself at one corner of the classroom and took field notes via classroom observation protocol.

The participants of this qualitative study were tenth-grade students. 25 students, 14 of them girls and 11 of them are boys, participated in this study. The data were collected through classroom observations and interviews. And the major advantage of observations for studying classroom contexts is painting a descriptive picture of the context (Turner & Meyer, 2000). To record the observations in a period of six courses, each of which is approximately 45 minutes long, we prepared classroom observation protocol, and apart from this we used audio recorder. After finishing observations, one of the researchers had conducted an interview with the teacher. This interview, which lasted for 20 minutes and is an audio recording made with the permission of the teacher, aimed to figure out teacher's perspective on teaching and learning and experience on teaching. In addition, the researcher made informal interviews with the teacher during recesses.

In this study, we used qualitative methods to analyze data, for qualitative approaches attempt *"to understand the qualities or essences of a phenomenon by focusing on the meanings of events and phenomena and the social events that transform these meanings"* (Behrens & Smith, 1996). It is a *"complex process that involves moving back and forth between concrete bits of data and abstract concepts, between inductive and deductive reasoning, between description and interpretation"*(Meriam, 1998). The use of qualitative methods within this socio-cultural setting is

important because, as Behrens and Smith (1996) noted, qualitative methods help us understand the black box that the classroom has become.

Field notes, which had been recorded during the observations, were in Turkish. Afterwards, the notes were translated from Turkish into English by an expert. The participants were given aliases during the data analysis. Data were analyzed through content analysis with the following process, as mentioned in Figure 1: First, we assigned repeating ideas from the relevant text (according to the purpose of the study) and second, we constructed themes and categories via gathering repeating ideas together (Auerbach& Silverstein, 2003).

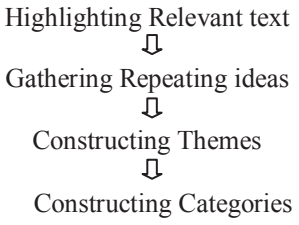

Figure 1. Qualitative Data analysis stages (Auerbach& Silverstein, 2003)

Besides, the data were coded and categorized by another research assistant, who is also a Doctoral Student at the department of Mathematics Education, to provide validity and reliability to this research. The categories constructed were compared to the categories constructed by the researchers, and a similarity above 70 % was noticed. A researcher, who has general information on the research topic and specialized on qualitative research methods, was asked to examine the study in order to provide research validity. Expert analysis contributed to the feedback with another point of view and to the research design, data gathering, analysis, reaching findings and comment phases to be valid and consistent (Patton,2002; Yıldırım&Şimşek, 2006).

3. Results

Data drawn from field notes and transcriptions of audio recordings of 6 lessons were analyzed to reveal the structure of mathematics classroom discussions. In analyzing the data, the unit of analysis was classroom discussions that involved the teacher's instruction and the students' participation in classroom discussions. Field notes, which had been recorded during the observations, were in Turkish. Consequently, they were translated from Turkish into English by an expert. The participants were given aliases during the data analysis. At this point, coding began by reading the data corpus of classroom observations (i.e., field notes integrated with audio recordings) for several times, searching for the examples of classroom discussions. Then we highlighted the relevant text related to classroom discussions. After we assigned repeating ideas from relevant text, we have constructed categories via gathering repeating ideas together (Auerbach& Silverstein, 2003).

The analysis of the data is presented to address the research questions. And the structure of the classroom discussions in a tenth-grade mathematics classroom is described and examined.According to the data, one of the categories is "classroom discussions are based on rules". Here are some examples, which the teacher and students use in classroom discussions:

- *If an equation has two roots, then $\Delta>0$.*
- *If the roots of an equation are equal,then $\Delta=0$.*
- *If an equation has no roots,then $\Delta<0$,*
- *In the $x^2 - Tx + Cx = 0$equation,*
  T is sum of the roots,Cis product of roots.

According to the observations it can be said that the teacher didn't ask explanatory questions, which involves "why" questions, with elaborate descriptions rather than brief or incomplete answers (Webb, 1991) to students. For

the teacher, whom we observed, that getting exploratory answers, "without answers fully intact" and as a "rehearsal of knowledge" (Barnes, 1976), is enough for answering a question. Besides, there is another excerpt, which is based on rules:

Teacher: $x^2 + 5x + n = 0,\ 2x^2 + mx + 3 = 0$ [Teacher is asking this question to the classroom]
In this equations roots are equal, so what should we do?
Student: Then, $\Delta=0$ [This answer comes from some of the students in classroom]

We can see in this example that students are accustomed to using this rule: *"If the roots are equal* $\Delta=0$*"* They don't think that there are two different equations, not just one. At this point, misunderstanding of the rule emerges. It can be said that they have just memorized the sentences without questioning. Another observation in the classroom is that the teacher doesn't give an opportunity to students to think about some questions. The teacher is looking for external criteria if the answer is right or wrong. There is an excerpt which explains this idea:

Teacher: Let's calculate general formula of $x_1^2+x_2^2$
Student: Is this b^2/a^2*?* [Without writing anything on the blackboard]
Teacher: No, Can we square it directly? [Student is looking around him and thinking]
No we cannot.
Teacher: Where does the square come from?
Write equal of this $(x_1+x_2)^2$*...*
Student: $x_1^2+x_2^2=(-b/a)^2$... [Writing this equation on the blackboard]
Teacher: But, Is this right? [Teacher is telling the equations and student is just writing them]
Write this:
$(x_1+x_2)^2 = x_1^2+x_2^2 + 2x_1x_2$
$x_1^2+x_2^2 = (x_1+x_2)^2 - 2x_1x_2$

4. Discussions

According to results, it can be said that the teacher and students generally use exploratory talk in classroom discussions. In his master thesis, Matson (2010) also figured out that the most common type of talk; accounting for the bulk of students talk overall, was exploratory talk. We found out that brief and right answers are what the teacher expects from students. Given that the teacher expects such outcomes, we realized that students just memorized the rules without reasoning and thinking on them. So we can say that the teacher's type of talk influence students' type of talk, as seen in Figure 2. Shortly, it can be said that students did, what their teacher expected from them.

Teacher's type of talk ⟹ Students' type of talk

Figure 2. Interaction between teacher talk and student talk

Finally, we mentioned that listening to students' talk about their own mathematical experience provides a data base for investigating students' learning on quadratic equations. In addition, for many students, the structure of the discussions allowed them to feel more comfortable and motivated to take part in the mathematics lessons, if their teachers give more opportunity to talk and think in front of the classroom with prompt questions.

References

Auerbach, C.F., & Silverstein, L.B. (2003). *Qualitative data: An introduction to coding and analysis.* New York: New York University Pres.
Barnes, D. (1976). *From communication to curriculum.* London: Penguin.
Behrens, J. T., & Smith, M. L. (1996). Data and data analysis. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of educational psychology* (pp. 945–989). New York: Simon & Schuster/Macmillan.

Esmonde, I. (2009). Explanations in mathematics classrooms: A discourse analysis. *Canadian Journal of Science, Mathematics and Technology Education,* 9(2), 86-99.

Gee, J. (1996). *Social linguistics and literacies: Ideology in discourses* (2nd Ed.). London: Taylor & Francis.

Hoyles, C. (1985). What is the point of group discussion in mathematics? *Educational Studies in Mathematics,* 16(2), 205-214.

Kim, D., Sfard, A., & Ferrini-Mundy, J. (2005). Students' colloquial and mathematical discourses on infinity and limit. Paper presented at the 29th Conference of the International Group for the Psychology of Mathematics Education, Melbourne, Australi.

Leder, G. (1990). Talking about Mathematics. *Australian Educational Researcher,* 17(2), 17-27.

Matson, C.L.H. (2010). Talking about Mathematics, Prompting Discussion among Community College Students in Algebra Tutoring. Thesis Submitted for the MSc in Mathematics and Science Education. AMSTEL Instituut, Universiteit van Amsterdam, Amsterdam, The Netherlands.

Merriam, S. (1998). *Qualitative research and case study applications in education*. San Francisco: Jossey-Bass

Moschkovich, J. (2003). What counts as mathematics discourse? In N. Pateman, B. Dougherty & J. Zilliox (Eds.), *Proceedings of the 2003 Joint Meeting of the PME and PMENA* (vol. 3, pp. 325-340). Honolulu, HI, University of Hawaii.

National Council of Teachers of Mathematics (2000). Professional Standards for Teaching Mathematics, NCTM, Reston, VA.

Patton, M. Q. (2002). *Qualitative Research & Evaluation Methods.* Thousand Oaks, CA: Sage.

Pimm, D. (1987). *Speaking mathematically: communications in mathematics classrooms.* London: Routledge & Kegan Paul.

Shuell, T. J. (1996). Teaching and learning in a classroom context. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of Educational Psychology* (pp. 726–764). New York: Simon & Schuster/Macmillan.

Turner, , Meyer, (2000). Studying and Understanding the Instructional Contexts of Classrooms: Using our Past to Forge our Future. *Educational Psychologist*, 35(2), 69–85.

Webb, N.M. (1991). Task-related verbal interaction and mathematics learning in small groups. *Journal for Research in Mathematics Education*, 22(5). 366-389.

Yıldırım, A. & Şimşek, H. (2006). *Sosyal Bilimlerde Nitel Araştırma Yöntemleri.* Ankara: Seçkin Yayıncılık.